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genes. There is a growing sentiment that all hereditary phenomena must rest in last analyses upon a chemical basis. DARBISHIRE[24] has made a careful examination of the starch grains of round and wrinkled peas in pure-bred strains and in several generations of their hybrids. He finds that there are several uncorrelated features of these starch grains which result in the hybrids having some of the characteristics of the starch grains of both the parents, thus tending to obscure the fact that the segregation of the starch characters is perfect.

Miss WHELDALE[25] has studied the floral pigments of a large number of species, devoting her attention most intently to the anthocyan series, but also including a discussion of xanthein, xanthin, and carotin. A useful summary is given of the studies of others upon the chemical composition of these compounds, and a large number of observations from her own analyses are presented, the general result being to show that there is a very large number of different pigments having a common fundamental structure which pass under each of these several names. From these analyses and from experience in cross-breeding she concludes that at least two features are necessary to the production of the anthocyan color: the one a colorless aromatic chromogen of the flavone series, the other an oxidizing agent which she believes to be a ferment. The details of Miss WHELDALE'S methods of analysis and the lengthy list of literature will prove of great value to students who desire to go into these more intimate problems of genetics.

A similar work from the animal side has been attempted by RIDDLE,[26] with respect to the melanin compounds, though the author presents no work of his own, simply bringing together in an instructive way the more recent results of investigations in this field. One unfortunate feature of RIDDLE'S work is his unfamiliarity with the Mendelian work from the experimental point of view. He thinks that he has proved the utter fallacy of the entire body of Mendelian teaching, and that he has demonstrated the continuity of the so-called unit characters, a statement which contravenes the experience of all investigators who have studied the behavior of pigment characters in actual breeding. No epigenetic hypothesis as yet gives the slightest hope of enabling such predictions as are successfully made continually by workers with the unit character conception.—GEORGE H. SHULL.

Perception of light.—HABERLANDT[27] attempts to strengthen his theory of light perception by plants, especially on the physiological side, acknowledging that the experimental work there leaves much to be desired, while the anatomical relations have been pretty fully cleared up. He discusses, therefore, the investigations that have attempted to eliminate the lens action of the papillose epidermis by making plane the surface with water, oil, gelatin, etc.; after which he addresses himself to the question of the residual lens action of the epidermal cells. He shows that in all cases with oblique illumination there remains an unequal excentric distribution of the brightness on the inner walls of the epidermal cells, though of less intensity than with dry epidermis. Inquiring into the sensitiveness of the cells in distinguishing differences of illumination, it appears that the more sensitive leaves have about the same capacity, 1/30, as the human eye under ordinary circumstances, the extremes being 1/75 and 1/12.5. But the differences of illumination in the case of papillose epidermis, even when wetted, is far above these figures, and, as HABERLANDT proceeds to show, is often greater even in leaves that have the epidermal cells plane outside and concave on the inner end. In the latter case the differences were from 1/15 to 10/1, according to the obliquity of the light.

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[24] DARBISHIRE, A. D., On the result of crossing round with wrinkled peas, with especial reference to their starch grains. Proc. Roy. Soc. London B **80**:122–135. 1908.

[25] WHELDALE, MISS M., The colors and pigments of flowers, with special reference to genetics. Proc. Roy. Soc. London B **81**:44–60. 1909.

———, On the nature of anthocyanin. Proc. Cambridge Phil. Soc. **15**:137–168. 1909.

[26] RIDDLE, O., Our knowledge of melanin color formation and its bearing on the Mendelian description of heredity. Biol. Bull. **16**:316–351. 1909.

[27] HABERLANDT, G., Zur Physiologie der Lichtsinnesorgane der Laubblätter. Jahrb. Wiss. Bot. **46**:377–417. 1909.

After discussing the previous more or less contradictory results of the wetting method, in which some of the experimental leaves were not in condition to perceive the direction of the light and to respond to it, he describes his new method. This consists of wetting only a part of a leaf of Tropaeolum with water made plane with a thin sheet of mica, and leaving the rest dry. A zone between the wet and dry portions is darkened with a paper screen, and the petiole is also properly protected. Then the two regions are illuminated obliquely from contrary directions. By varying the relative areas of the wet and dry regions, and the intensity of the illumination, it is easy to determine the relative efficiency of the epidermis under the two conditions. When the areas are equal and the wet area receives double the intensity of light, its direction on the dry side controls the response. When the intensities are equal and the wet area is 2.2–4.8 times the dry, the latter still dominates the reaction.

We translate the latest statement of HABERLANDT'S theory: "The perception of the direction of light results, according to my theory, from the differences in brightness or the different distribution of intensity upon the inner walls of the epidermis, which may be brought about in various ways. The smaller differences of brightnesss may be produced by the mere convexity of the inner walls of the epidermis. These *must* suffice as a stimulus (*müssen die Reizschwelle erreichen*) if the outer walls are plane and concentration of the light is thus excluded; and they *may* suffice even if the normal collection of light by convex outer walls is made impossible by wetting. Then even the wet leaf perceives the direction of the light and returns, although slowly and generally incompletely, to the usual light position. In these cases the epidermal cells act as optical stimulators, and and though they may be dispensed with to a certain extent, the promptness and precision of the movement are enhanced by their effect in increasing the intensity of the stimulus. This action is especially valuable in the last phases of the adjustment, when by the diminution of the angle of incidence, the differences of brightness on the inner walls, so far as these differences are due to the convexity of the inner walls, may become less and less until they fall below the liminal value as a stimulus."—C. R. B.

Symbiosis in orchids.—A recent paper by BERNARD[28] recalls his previous studies on the germination of certain orchid seeds and on the relation of fungi to the tuberization of orchids and potatoes. The present paper advances our knowledge of these fungi and places considerable emphasis upon their place in the development of the orchid group. Three species (*Rhizoctonia repens*, *R. lanuginosa*, and *R. mucoroides*) have been recognized, described, isolated, and grown in pure cultures for considerable periods. Although no spore-bearing structures have been observed, they probably belong to the lower basidiomycetes. The first-named species seems to be the most primitive and most widespread in its symbiosis.

Two series of orchids were studied, those of epiphytic and those of terrestrial habit. The growth of the seedlings was accomplished experimentally in test tubes upon suitable media, and the effect of the fungi and of various concentrations of the media upon their development carefully studied. The results are most interesting and suggestive, and may be summarized as follows: (1) Orchids exhibit a progressive development of symbiosis corresponding to and probably in some measure the cause of their development in phylogenetic series. (2) The evolution in epiphytic and terrestrial families is parallel, and symbiosis is the only common factor which can account for this parallelism. (3) The evolution in symbiosis manifests itself in an advance from independent germination of seeds with normally developed seedlings, to a germination entirely dependent upon the infection of the embryo by fungi and the development of seedlings characterized by protocorms. In the adult plants various progressive stages of symbiosis are exhibited, from an intermittent infection with sympodial habit to permanent symbiosis associated with the monopodial habit of the host. (4) The fungi vary in virulence according to their species, their host, and the length of time they have lived outside those hosts. Very virulent cultures act upon more highly developed orchids in a similar manner to more attenuated cultures upon more primitive species. (5) Concentrated solutions of the culture media have an effect upon germination similar to that produced by infection by fungi, and both symbiosis and growth in concentrated media result in increasing the concentration of the cell contents, which seems to be the necessary condition for the development of these specialized plants.—GEO. D. FULLER.

Recent contributions from the Gray Herbarium.[29]—A. EASTWOOD (Proc. Am. Acad. **44**:563–591. 1909) has published a "Synopsis of the Mexican and

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[28] BERNARD, NOËL, L'évolution dans la symbiose. Les orchidées et leurs champignous commensaux. Ann. Sci. Nat. Bot. IX. **9**:1–196. 1909.

[29] Contributions from the Gray Herbarium of Harvard University, New Series, No. XXXVI (Proc. Am. Acad. **44**:563–637. 1909); and No. XXXVII (Proc. Bost. Soc. Nat. Hist. **34**:163–312. *pls. 23–30.* 1909).